The influence of long-term fertilization on species diversity and yield potential of permanent meadow stand

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ABSTRACT

Long-term fertilization of meadow stands affects the species composition, yields, and general pratotechnics. Observations were realised on a plane meadow of a mesophyte character in 1976–2000 years. Four variants were observed in the experiments (N_0, $N_0P_{40}K_{100}$, $N_{100}P_{40}K_{100}$, $N_{200}P_{40}K_{100}$) in four replications. Species composition of grass stands was variable in the followed period in the leaf area from 66 to 95% of the dominance (Table 1). Total abundance of species with PK-fertilization was almost identical in individual pentads (24–28 species) as it is evident in Table 2. Table 3 proves the highest dominance was found at *Dactylis glomerata* L. in the first five years. Rhizomatous grasses had the highest leaf area with 38–55% of the dominance on variants with the higher N doses (200 kg N/ha) + PK (Table 4). Table 5 demonstrates that the variant without fertilization showed nearly stable abundance of species with the higher than 1% (11–13). Reduction of species number especially with the dominance higher than 1% (5–11) followed at the highest N-fertilization in comparison with the check variant. The mean yield of dry matter was 2.75 t/ha, the stand fertilized by 40 kg P + 100 kg K/ha gave 30.6% increased of yield (Table 7). The highest yields were recording in the second year of the N-fertilization (8.28 and 10.12 t/ha).

Keywords: permanent meadow stand; species diversity; yields

Species composition in meadow stands is very important not only for their productive abilities and evaluation of qualitative characters of the produced matter, but also for the methods and intensity of their control, it means for the selection of the best pratotechnical arrangements. The floristic composition of permanent meadow stands (PMS) is the resulting point of the interaction of all ecological factors in the whole ecosystem and the controlled conditions. Krahulec et al. (1996) show that the purposive cultivation of PMS is necessary for the preservation of the entire species diversity and their protective functions.

Grass stands are significantly important for the biodiversity presentation mainly of the rare and endangered species. Extraordinary variability in ecological conditions shows up in the variability of natural grass associations. Hejduk and Hrabě (1999) proved that the botanical composition PMS is not permanently stabile and changes according to the ecological factors. Each change in stand conditions results in the changes of species composition, representation of agrobotanical groups and PMS yields. The most significant influence is presented by fertilization. Nitrogen fertilization partly improves the influence of less favourable stand conditions on matter yields and quality, but its productive efficiency is lower (Holúbek et al. 1977). Nitrogen fertilization, mainly its higher doses, affects the stand composition most intensively and rapidly. Systematic fertilization with higher N doses (120 kg/ha) causes the widening of rhizomatous grasses after a certain period (Velich 1985, Klimeš 1999a, etc.). Majority of authors state, that the nitrogen fertilization raises the expansibility of mainly upgrowing species, giving higher yields, especially of biomass (Krajčovič et al. 1967, Lichner et al. 1977). According to Klimeš (1999b), the yielding ability of grass stands depends on their locality. The highest theoretical yield levels were obtained in Šumava district (550 m above sea level) regardless of nitrogen doses. After opening the N + PK fertilization experiments the highest matter yields were obtained in the first two or three years (Velich 1985). Other authors give some conclusions (Kasperczyk et al. 1998, Mrkvička and Veselá 1999 and others).

The influence of phosphorus fertilization on yield increases is slow at first and fully effective after some years due to a little mobility of phosphorous ions. The sufficient phosphorus fertilization is particularly important at higher nitrogen doses (Velich 1985).

Potassium is characterized by an easy intake and is considerable unstable in plants. The influence of potassium is not definite. It has a great positive influence on the botanical composition of stands. It supports the occurrence of valuable grass species and some leguminous plants. A systematic one-sided potassium application causes an unfavourable spread of mainly broad-leaved weed species. Vaněk and Balík (1993) show that the relationship between potassium intake and its and nitrate content in plants cannot be generalised definitely. The intake of both ions is conditioned by more factors, mainly by sorption affinity of individual plants, meteorological conditions within plant growth etc. Velich (1985) found out that the reaction of grass stands on PK-fertilization was very variable in individual meadow stands and was not dependent on the part of leguminoses in the original stands. The most efficient was PK-fertilization in

stands with generally favourable conditions for leguminoses and the same time with a lower content of available P and K in the soil. The productive effect of PK-fertilization is higher if the lack of these nutrients is removed and the stand conditions for leguminous plants are most favourable.

The production ability of stands and its reaction to pratotechnics depends on species composition, which is determined by stand conditions, mainly by the state of water and nutrient soil regime.

MATERIAL AND METHODS

The experiment was founded in 1976 on a plain permanent meadow of mesophytic character in the locality of Senožaty (Pelhřimov district) which originated in the original grass stand sown in 1964. The hight above sea level is 485 m, the average annual precipitation sum 641 mm, (402 mm during vegetation period), average annual temperature 7.0°C, Lang's rainfall factor 92. Depth of underground water level 0.6 m (0.3–1.0 m). Soil type pseudogley, soil species sandy loam, pH 5.1, % C_{ox} 2.16, % N_{tot} = 0.39, C_{tot}:N_{tot} = 5.54. Maximum sorption capacity (*T*) = 25.0 mval./100 g of soil, saturation of sorption complex by bases (*V*) = 52.0%.

Four variants were studied in the experiment. Check variety 40 kg P/ha + 100 kg K/ha, 100 kg N/ha (+ PK) and 200 N/ha (+ PK). Split N doses (in saltpeter ammonia 27.5%) were applied at the beginning of spring overgrowing and after the first cut. Phosphorus was applied in autumn by means superphosphate and potassium by means of potassium salt after first cut (Velich and Mrkvička 1988). Botanical analyses of stands were done by the method of reduced projective dominance (*D* in % before first cut harvest). Basic agro-botanical groups were separated according to the individual species and for the accuracy increase, the weighing method. The cut green matter was weighed up, mean samples for dry matter determination and chemical analyses were taken away.

RESULTS AND DISCUSSION

Species stand composition was partly influenced by the composition of sown mixture. Total leaf area (% of dominance = *D*) in 1976 was 95%. Grasses with the leaf area 55% dominated in the stand and 49% of it covered cultural grasses and 6% uncultural ones. The highest dominance was present at *Dactylis glomerata* L. (20%) and *Poa pratensis* L. (20%). The same leaf area was observed at *Festuca rubra* L. and *Anthoxanthum odoratum* L. (6%). *Arrhenatherum elatius* Presl. showed 3% *D*. Only single occurrence (+) was proved at *Festuca pratensis* Huds., *Trisetum flavescens* P. Beauv., *Holcus lanatus* L., *Agropyron repens* (L.) Desv., *Agrostis stolonifera* L. and *Phleum pratense* L. The area of leguminose leaves was 25% dominance. *Trifolium repens* L. (15%) and *Trifolium pratense* L. in 5% dominance were the most frequent species in the clover cultures. *Lotus corniculatus* L. occurred only sporadically. The most spread uncultural leguminous plants appeared: *Lathyrus pratensis* L. (4%) and *Trifolium dubium* Sibth. (1%). Total area of dicotyledonous species was 15% and the highest dominance appeared in *Taraxacum officinale* Web. (8%) and *Achillea millefolium* L. (3%). The same dominance was observes at *Alchemilla vulgaris* L. and *Plantago lanceolata* L. Total number of species with dominance 1% was 13, 12 species from that number appeared sporadically (+). Tables 1–4 show the meadow year variability of dominance of species in pentads at four studied variants in 1976–2000.

It is evident (Table 1), that species composition of grass stands was variable in the followed period in the leaf area of individual species. Hejduk and Hrabě (1999) proved the dependence on of the species on ecological factors. *Dactylis glomerata* L. (from 20 to 1%) showed the decrease caused by a low nutrient reserve and lower perenniality. The leaf area did not caused significantly a change in *Poa pratensis* L. during the experimental years and *Festuca rubra* L. sowed a changeable leaf area. *Trifolium repens* L. and *Lathyrus pratensis* L. showed the highest leaf area of legumes, which widened more significantly in the last period. The other dicotelydenous species included mainly *Taraxacum officinale* Web. with the exception of the tenyears cycle and *Leon-todon autumnalis* L., mostly spread in the period of 15 years (1981–1995).

Total abundance of species with PK fertilization was almost identical in individual pentads (24–28 species) as it is evident in Table 2. The leaf area of individual species changed, especially at sparsly turf *Dactylis glomerata* L. in companion with the original stand, mainly by 10%. The occurrence of *Dactylis glomerata* L. was higher compared with the check variant, probably due to increased leguminose leaf area and rhizobial nitrogen. *Poa pratensis* L. showed the highest dominance (20–30%) and *Festuca rubra* L. had a stable leaf area (3–7% *D*). The highest leaf area in the first pentad of studies appeared at *Trifolium repens* L. and *Trifolium dubium* Sibth. In 1981–1985 *Lathyrus pratensis* L. expanded. Relatively stabile was *Taraxacum officinale* L., belonging to the other dicotelydonous species. Since 1981, the occurrence of *Alchemilla vulgaris* L., *Achillea millefolium* L. and within 15 years *Plantago lanceolata* L. and *Leontodon autumnalis* L. has been observed. Since 1981 the dominance of dicotelydonous species (15–35%) has been increased. Velich (1985) described the species composition, which was dependent on PK-fertilization of five meadow stands. Table 3 proves the highest dominance was found at *Dactylis glomerata* L. (30–50%) in the first five years. The second widespread species was *Arrhenatherum elatius* L. After 1981 the invasion of rhizomatous species was observed, mostly *Poa pratensis* L. and *Festuca rubra* L. *Trifolium repens* L. resisted generally to N-fertilization (100 kg/ha). This level of fertilization caused an increase of *Taraxacum officinale* L. Since 1981 the dominance of leguminoses has been decreased and the pres-

Table 1. Average dominance (in % *D*) species of control variant in pentads, 1976–2000, locality Senožaty

Species	% *D*					
	1976	1976–1980	1981–1985	1986–1990	1991–1995	1996–2000
Dactylis glomerata	20	10	5	1	1	1
Poa pratensis	20	19	20	15	5	15
Festuca rubra	6	1	5	15	5	15
Anthoxanthum odoratum	6	10	2	3	3	1
Arrhenatherum elatius	3	+	1	+	+	+
Holcus lanatus	+	+	1	2	+	3
Agrostis stolonifera	+	+	+	5	5	2
SD grasses	55	41	34	41	19	37
Trifolium pratense	5	5	+	4	3	+
Trifolium repens	15	2	+	1	3	10
Lathyrus pratensis	4	5	+	+	+	15
Trifolium dubium	1	5	1	+	+	5
Lotus corniculatus			4	4	9	+
SD legumes	25	17	5	9	15	30
Taraxacum officinale	8	30	+	1	15	15
Alchemilla vulgaris	2	1	1	+	1	+
Achillea millefolium	3	1	2	1	+	1
Plantago lanceolata	2	+	4	1	4	2
Leontodon autumnalis			20	15	10	
SD dicotyledonous	15	32	27	18	30	18
Total leaf area	95	90	66	68	64	85
Abundance of species $D \geq 1$	13	11	12	13	12	12
Abundance of species $D < 1$ (+)	12	11	14	14	13	17
Total number of species	25	22	26	27	25	29

Table 2. Average dominance (in % *D*) species of variant fertilized $N_0P_{40}K_{100}$ in pentads, 1976–2000, locality Senožaty

Species	% *D*					
	1976	1976–1980	1981–1985	1986–1990	1991–1995	1996–2000
Dactylis glomerata	20	10	10	3	10	10
Poa pratensis	20	30	20	20	25	25
Festuca rubra	5	5	5	3	7	7
Holcus lanatus	1	+			+	
Deschampsia caespitosa				3	+	3
Anthoxanthum odoratum	7	+	+	3	3	3
Arrhenatherum elatius	3	3	1	5	5	4
SD grasses	56	48	36	37	50	52
Trifolium pratense	5	5	+	1	1	5
Trifolium repens	5	30	+	15	8	5
Lathyrus pratensis	+	2	10			+
Trifolium dubium	10	10	5	1	1	5
Lotus corniculatus	+	+	5	+	+	+
SD legumes	20	47	20	17	10	15
Taraxacum officinale	4	5	20	5	5	8
Alchemilla vulgaris	+	+	5	1	1	2
Achillea millefolium	+	+	5	3	2	8
Plantago lanceolata	1	+	2	1	2	+
Leontodon autumnalis		+	3	8	5	
Cardamine pratensis						2
SD dicotyledonous	5	5	35	18	15	20
Total leaf area	81	100	91	72	75	87
Abundance of species $D \geq 1$	11	9	12	14	13	12
Abundance of species $D < 1$ (+)	13	15	12	11	13	16
Total number of species	24	24	24	25	26	28

Table 3. Average dominance (in % *D*) species of variant fertilized $N_{100}P_{40}K_{100}$ in pentads, 1976–2000, locality Senožaty

Species	% *D*					
	1976	1976–1980	1981–1985	1986–1990	1991–1995	1996–2000
Dactylis glomerata	30	15	1	1	2	5
Poa pratensis	9	20	30	25	25	20
Alopecurus pratensis			+	+	+	2
Festuca rubra	8	4	20	20	15	10
Holcus lanatus	+		+	+	1	3
Anthoxanthum odoratum	8	1	+	2	2	3
Arrhenatherum elatius	30	10	10	10	15	20
Agropyron repens		+	+	+		2
SD grasses	85	50	61	58	60	65
Trifolium pratense	1	6	+		+	+
Trifolium repens	1	2	2	+	7	2
Lathyrus pratensis		6	1		+	1
Trifolium dubium	1	6	1	1	3	
Lotus corniculatus	+	+	2			2
SD legumes	3	20	6	1	10	5
Taraxacum officinale	5	5	5	12	13	15
Alchemilla vulgaris	+	+	2	5	2	+
Achillea millefolium	+	+	5	2		4
Plantago lanceolata	2	+	+	+		+
Leontodon autumnalis	+	+	2	+		
Cerastium arvense	+	+	+	+	+	1
SD dicotyledonous	7	5	14	19	15	20
Total leaf area	95	75	81	78	85	90
Abundance of species $D \geq 1$	10	10	12	9	10	14
Abundance of species $D < 1$ (+)	16	14	11	14	12	10
Total number of species	26	24	23	23	22	24

Table 4. Average dominance (in % *D*) species of variant fertilized $N_{200}P_{40}K_{100}$ in pentads, 1976–2000, locality Senožaty

Species	% *D*					
	1976	1976–1980	1981–1985	1986–1990	1991–1995	1996–2000
Dactylis glomerata	40	10	5	1	10	5
Poa pratensis	10	35	50	28	24	28
Festuca rubra	5	10	5	18	14	15
Trisetum flavescens	+			+		2
Anthoxanthum odoratum	5	+	+	1	1	3
Arrhenatherum elatius	30	30	30	20	25	20
Deschampsia caespitosa						2
Phleum pratense	+	+	1	+		+
SD grasses	90	85	91	68	74	75
Trifolium dubium		+	+	1	+	+
Lotus corniculatus	1		2			
SD legumes	1	+	2	1	+	+
Taraxacum officinale	8	5	4	10	10	10
Alchemilla vulgaris	+	+	+	4	3	2
Achillea millefolium	+	+	1	2	2	1
Plantago lanceolata	1	+	+	+		+
Cerastium arvense	+	+	+	+		2
SD dicotyledonous	9	5	5	16	15	15
Total leaf area	100	90	98	85	89	90
Abundance of species $D \geq 1$	8	5	8	9	8	11
Abundance of species $D < 1$ (+)	17	15	13	13	11	9
Total number of species	25	20	21	22	19	20

Table 5. Abundance of species in pentads by different intensity of fertilizing grassland, locality Senožaty

Variants	Abundance of species $D \geq 1$/Abundance of species $D < 1$ (+)					
	1976	1976–1980	1981–1985	1986–1990	1991–1995	1996–2000
Control	13/12	11/11	12/14	13/14	12/13	12/17
$N_0P_{40}K_{100}$	11/13	9/15	12/12	14/11	13/13	12/16
$N_{100}P_{40}K_{100}$	10/16	10/14	12/11	9/14	10/12	14/10
$N_{200}P_{40}K_{100}$	8/17	5/15	8/13	9/13	8/11	11/9

ence of the other dicotyledonous species has been increased.

The higher N doses (200 kg/ha) influenced the species dominance most intensively (Table 4). Rhizomatous grasses had the highest leaf area (*Poa pratensis* L., *Festuca rubra* L.) and *Arrhenatherum elatius* L. showed nearly stable leaf during the experimental period. Leguminous plants appeared sporadically. *Taraxacum officinale* L. prevailed from the beginning of the experimental work abd its dominance gradually increased. After 1986 *Alchemilla vulgaris* L. and *Achillea millefolium* L. expanded. The increase N level reduced the number of species with $D \geq 1$ in comparison with the data in Table 3. Similar changes in species diversity of meadow stands in different ecological conditions observed Lichner et al. (1977), Kasperczyk et al. (1998), Klimeš (1999a, b) and others.

Table 5 demonstrates that the variant with no fertilization showed nearly stable abundance of species with the dominance higher than 1% (11–13) and the number of species having sporadic occurrence (11–17) increased only temperately. The total number of species with PK-fertilization was stable until 1986 (24) and later moderately increased largely at sporadically occurring plants. Reduction of species number especially with the dominance higher than 1% (5–11) followed at the highest N-fertilization (+ PK) in comparison with the check variant. In the experimental period there occurred of sparsly taft grasses in all the variants due to their lower pereniality (Table 6). The most significant decrease of dominance appeared in the check variant (by 83%) and in the plot fertilized by PK (by 45%). Relatively lower decrease of leaf area of sparsly turf grasses caused by nitrogen fertilization. The dose of 100 kg N/ha (+ PK) caused the decrease of dominance of sparsly turf grasses by 54%, after the application of 200 kg N/ha (+ PK), by 60% in comparison with the initial state.

Dominance of turf grasses in the check variant ranged from 15 to 37% and at PK-fertilization in the range of 23–25%. *Poa pratensis* L. and *Festuca rubra* L. dominated in the stand at nitrogen fertilization together with the reduction of sparsly turf grasses, especially *Dactylis glomerata* L. During the experimental period the rhizomatous grass species expanded in the variants with gradual N-fertlization by 100%, 187% respectively. Velich (1985), Klimeš (1999a, b) proved, that the long-term fertilization by higher nitrogen doses supports the increase of rhizomatous grasses.

It is evident (from the Table 7), that the mean yield of dry matter from the check variant during the experimental period was 2.75 t/ha, ranging from 1.4 (1983) to 4.20 t/ha in 1977. The stand feritilized by 40 kg P + 100 kg K/ha gave 30.6% increased yield in comparison with check plot. Similarly the lowest yield of dry matter was found in 1983 (1.40 t/ha) and the highest level was determined in 1999 (6.61 t/ha). Relative comparison of yields in the variant with phosphorus-potassium fertilization with the check area showed the increasing level from 25–40% in the course of pentads. A reverse trend was proved at the both levels of nitrogen nutrition (+ PK), when the highest yields were obtained in the first pentads. Mean relative yields of dry mass increased by 85–95% compared with the variant without fertilization (1976–1985) if the doses were lower. The highest yields were obtained in

Table 6. Dominance (in % *D*) sparsly taft and rhizomatous grass species in pentads, locality Senožaty

Variants	Grasses	Average dominance (*D* in %)					
		1976	1976–1980	1981–1985	1986–1990	1991–1995	1996–2000
Control	sparsly taft	29	20	9	4	4	5
	rhizomatous	26	20	25	37	15	32
$N_0P_{40}K_{100}$	sparsly taft	31	13	11	11	18	17
	rhizomatous	25	35	25	23	32	32
$N_{100}P_{40}K_{100}$	sparsly taft	68	26	11	13	20	31
	rhizomatous	17	24	50	45	40	34
$N_{200}P_{40}K_{100}$	sparsly taft	75	40	36	22	36	30
	rhizomatous	15	45	55	46	38	43

Table 7. Yields of dry matter (t/ha) by different level of fertilizing, locality Senožaty

Years	Fertilizing			
	N_0	$N_0P_{40}K_{100}$	$N_{100}P_{40}K_{100}$	$N_{200}P_{40}K_{100}$
1976	2.82	3.64	6.02	8.32
1977	4.20	5.82	8.28	10.12
1978	3.97	4.41	6.26	8.72
1979	2.86	3.09	4.72	6.51
1980	2.62	3.64	5.11	7.63
Average 1976–1980	3.29	4.12	6.08	8.26
Relatively in %	100.0	125.2	184.8	251.0
1981	2.46	3.31	5.26	8.87
1982	2.60	3.13	5.02	7.31
1983	1.04	1.40	2.68	5.07
1984	2.05	2.75	3.66	4.22
1985	1.96	2.27	3.02	3.26
Average 1981–1985	2.02	2.57	3.93	5.75
Relatively in %	100.0	127.2	194.6	284.7
1986	2.62	2.99	3.65	4.85
1987	2.17	2.82	3.72	4.29
1988	2.15	2.60	3.43	4.27
1989	3.66	3.95	4.82	5.06
1990	2.25	3.81	4.56	4.97
Average 1986–1990	2.57	3.23	4.04	4.67
Relatively in %	100.0	125.7	157.2	181.7
1991	3.78	4.85	7.24	8.46
1992	1.64	2.39	4.20	4.39
1993	1.19	2.32	2.54	4.54
1994	3.13	3.50	3.96	4.16
1995	3.62	4.86	5.19	7.25
Average 1991–1995	2.67	3.58	4.63	5.76
Relatively in %	100.0	134.1	173.4	215.7
1996	3.27	3.71	5.13	5.55
1997	3.80	3.95	5.25	5.82
1998	2.52	4.80	6.46	6.54
1999	3.72	6.61	7.22	8.26
2000	2.67	3.25	4.08	4.81
Average1996–2000	3.20	4.50	5.63	6.20
Relatively in %	100.0	140.6	175.9	193.8
Average1976–2000	2.75	3.60	4.86	6.13
Relatively in %	100.00	130.68	176.65	222.84

D_{min} α 0.05 = 0.564

the second year of the N-fertilization (8.28 and 10.12 t/ha). The yield capacity of meadow stands depends, in addition to the nitrogen nutrition, on the conservative ecological factors (Holúbek et al. 1997, Klimeš 1999a,b, and others).

According to the Tukey's test the yields of dry mass in experimental variants are significant on the 95% level in the period of determination.

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Table 8. The influence of fertilizing on yields of dry matter (1976–2000)

Variants of fertilizing	Number of cases	Average	Homogenous groups
N_0	25	2.7508	*
$N_0P_{40}K_{100}$	25	3.5948	*
$N_{100}P_{40}K_{100}$	25	4.8592	*
$N_{200}P_{40}K_{100}$	25	6.13	*

T-method

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ABSTRAKT

Vliv dlouhodobého hnojení na druhovou diverzitu a výnosový potenciál trvalého lučního porostu

Floristické složení trvalých travních porostů (TTP) je výslednicí působení interakcí všech ekologických faktorů celého ekosystému a podmínek jeho obhospodařování. Každá změna stanovištních podmínek vyvolává diference v druhovém složení, v zastoupení jednotlivých agrobotanických skupin a ve výnosnosti TTP. Nejvýraznější vliv na druhovou diverzitu má hnojení a jeho intenzita. N hnojení, zvláště při vyšších dávkách, působí na složení porostu nejrychleji a nejvýrazněji. Dominance druhů a výnosová schopnost byly sledovány na trvalé louce mezofytního charakteru v letech 1976 až 2000. V pokusu byly sledovány čtyři varianty (v kg/ha): N_0 (varianta kontrolní), $N_0P_{40}K_{100}$, $N_{100}P_{40}K_{100}$ a $N_{200}P_{40}K_{100}$. Dělené dávky N (v LAV 27,5 %) byly aplikovány na počátku jarního obrůstání a po 1. seči. Fosfor byl aplikován na podzim ve formě superfosfátu a draslík v draselné soli po 1. seči. Botanické rozbory porostů byly provedeny metodou redukované projektivní dominance (*D* v %) před sklizní 1. seče. Celková pokryvnost porostu (v % dominance = *D*) v roce 1976 byla 95 %. V porostu převládaly trávy s pokryvností 55 %. Z trav největší dominanci měly *Dactylis glomerata* L. (20 %) a *Poa pratensis* L. (20 %). Z kulturních jetelovin byly nejrozšířenější *Trifolium repens* L. (15 %) a *Trifolium pratense* L. s dominancí 5 %. Celková pokryvnost dvouděložných druhů byla 15 %, z toho největší dominanci měly *Taraxacum officinale* Web. (8 %). Dalšími doprovodnými druhy byly *Achillea millefolium* L. a *Allchemilla vulgaris* L. Tab. 1 až 4 uvádějí průměrnou roční variabilitu dominance druhů v pentádách u čtyř sledovaných variant. Početnost druhů s různou dominancí $D \geq 1$ a $D < 1$ (+) v pětiletých cyklech popisuje tab. 5. Varianta bez hnojení vykazovala téměř stabilní abundanci druhů s dominancí vyšší než 1 % (11–13) a mírně narůstala početnost druhů s ojedinělým výskytem (11–17). Celkový počet druhů při PK hnojení byl do roku 1986 stabilní (24) a později mírně narůstal, převážně u rostlin s ojedinělým výskytem (+). Při nejvyšší úrovni N hnojení (+ PK) nastala redukce počtu druhů, zvláště s dominancí vyšší než 1 % (5–11) v porovnání s kontrolní variantou. Ve sledovaném období docházelo ke snížení dominance volně trsnatých trav u všech variant v důsledku jejich nižší vytrvalosti (tab. 6). Při aplikaci zvýšených dávek N hnojiva s postupem let se rozšiřují rhizomatické druhy trav, převážně *Poa pratensis* L. a *Festuca rubra* L. Zvýšenému N hnojení ($N_{100}P_{40}K_{100}$) nejlépe odolával *Trifolium repens* L. a nekulturní druhy jetelovin. Z tab. 7 je zřejmé, že průměrný výnos suché píce kontrolní varianty za sledované období byl 2,75 t/ha. Porost hnojený dávkami 40 kg P/ha + 100 kg K/ha poskytl výnos o 30,6 % vyšší v porovnání s kontrolní plochou. Relativní porovnání výnosů u varianty s PK hnojením s kontrolní plochou vykázalo v průběhu pentád zvyšující se úroveň od 25 do 40 %. Opačný trend jsme zaznamenali při obou úrovních N výživy (+ PK), kdy nejvyšších výnosů bylo docíleno v prvních pentádách. Průměrné relativní výnosy suché hmoty byly při nižší dávce N o 85 až 95 % vyšší oproti nehnojené variantě. Podle *t*-testu jsou výnosy suché hmoty jednotlivých variant ve sledovaném období průkazné na hladině významnosti 95 % (tab. 8).

Klíčová slova: trvalý luční porost; druhová diverzita; výnosy

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